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Establishing the High Density Supported Apple Orchard

Part 1: Site Selection and Preparation

Revised: January 1998
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Foreward

There are many different systems and approaches that could be used successfully to establish a new apple orchard. This report summarizes the main process required to establish a High Density Supported Apple Orchard. This document will evolve as new knowledge and experience with these systems is gained in Ontario. Be sure to consult the most recent issue.

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Introduction to High Density Apple Orchards

The decision to plant a high density supported apple orchard requires a total commitment to this approach. The grower must be prepared to acquire new skills and to do what needs to be done exactly when it needs to be done. With higher density plantings, the impact of a mistake is potentially much greater than with lower density plantings. Add to this the high cost of establishment and one can knowingly say the risks are high. The rewards, however, are also high in terms of yield and quality of apples. Done properly, a grower should realize a marketable yield from a mature planting of 2000 - 2500 bushels per hectare (800 - 1000 bushels per acre) or more depending on cultivar. Unless these levels of yields are achieved there is probably little advantage to a high density supported system over a well managed, free standing system of lower density.

There are several variations available in the type of support system that can be

used. Recent studies suggest that density of planting (trees/acre), cultivar selected, and grower management is a bigger factor in the success of a new planting than the exact support system used.

High-density apple orchards cost more to establish than lower-density orchards. The cost to establish a high density supported orchard at 600 tress/acre could be over $12,000 per acre. Increased costs for a new high-density apple orchard are justified only if returns are generated early to offset these costs. To pay off higher initial costs rapidly, the new orchard must come into production very quickly. The cultivar selected must produce fruit of adequate market value to quickly recover the cost of establishment. To plant a cultivar on a high density supported system that has minimal market value will be a costly mistake.

Success in the apple business in the future is going to require long range planning. Conversion to higher density supported systems has to be slow, slow enough that the grower and nurseryman can stay abreast of the latest technology and changes, and slow enough that the costs of conversion do not exceed the grower's ability to finance successfully.

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Orchard Location

Site considerations are crucial; so is the time spent in proper preparation. Every attempt must be made to select a site where dwarfing rootstocks with limited root systems will perform well. It is important to choose a site for an apple orchard close to the **moderating effect** of a large body of water. In Ontario, all successful apple areas are in proximity to one of the Great Lakes and benefit from the climate moderation provided by these large deep bodies of water. Because large bodies of water take a long time to change in temperature, temperature extremes are reduced in both the summer and winter. Their cooling effect in the spring delays the onset of bloom, lessening the risk of damage from spring frosts. In the fall their effect reduces the onset of cold temperatures and the damaging effect these can have on unharvested apples and on trees before they completely harden off.

The **elevation** of an orchard is important for avoiding spring frosts. A higher elevation relative to the surrounding area is desirable because heavier cold air, in the spring, will flow into the lower areas. This makes low areas frost prone resulting in poor tree performance with crop loss and/or damaged fruit. Avoid any obstructions to downward flow of air such as woods, a hedgerow, buildings or even a heavily travelled highway. Woods or hedgerows can be opened to allow airflow by creating 25 m openings every 100 m.

A gentle **slope** is most desirable. Steep slopes make orchard activities more difficult and are susceptible to soil erosion. Northern slopes are most desirable because they tend to result in delayed bud development in the spring; however, other factors may be important such as reducing exposure to the prevailing wind.

Wind is another consideration. Windy sites should be avoided. Strong winds can reduce the growth rate of trees, increase fruit bruising and fruit drop at harvest, reduce bee activity during pollination and make effective spraying more difficult. Windbreaks can help but excessive snow build up, increased shading and slower drying in the orchard resulting in an increase in fruit and leaf diseases, are drawbacks.

Availability of **water for irrigation** is another important consideration when selecting a planting location. Dwarfing rootstocks have a limited root volume and moisture levels deemed adequate for more vigorous rootstocks may be deficient for dwarfs. A dependable supply of good quality water for irrigation is needed. The

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taking of this water must not have any long term implications to the local environment or short term regards concerning interference with other users. You should have an estimate of how much water might be needed. The location of the water supply (horizontal distance and vertical lift) will impact on the cost and design of the irrigation system. A moisture equivalent of 2.5 cm of water per week from rain and/or irrigation is usually adequate to avoid drought stress. A source of water nearby that would be adequate for a growing season may well be necessary to grow dwarfing rootstocks successfully. For more information on irrigation and water requirements consult the publication entitled, "Best Management Practices - Irrigation Management" , at an OMAFRA field office.

The range of soil and climate conditions that are acceptable for high density orchards is narrower than for lower density orchards. Even if a low density planting grew successfully on a location it may not be a good location for higher density plantings. A thorough knowledge of any previous orchard or other crop problems is a vital first step in assessing the suitability of your chosen site. With the considerable investment in a high density orchard, you must be able to bring the site up to the exacting requirements of a high density orchard, or seek an alternate site.

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Soil Drainage

The removal of excess water from the soil profile is the form of drainage often forgotten by apple growers. Under no conditions should apple trees stand in water for more than one or two days. Root suffocation will occur under such circumstances resulting in tree injury and/or death. For trees to produce well on the dwarfing rootstocks used in high density plantings, the drainage must be nearly perfect. Improving drainage is most effectively done by tiling. Additional drainage from pockets of wet areas may be handled using raised beds after tiling is installed. Usually it is the heavier clay soils that require drainage improvement, but problems have also been encountered in orchards on sandy soils where the water table is high. Wet spots may be effectively drained using irregular patterns. Generally, a systematic drainage pattern is often required and on some sites the distance between tile lines may need to be as close as every tree row. Tile drainage should be installed before planting by a qualified contractor.

Poor water drainage down through the profile may be a result of the existence of a hard pan or a compacted layer in the sub-soil. This can be readily detected by close observation of inspection holes that are hand dug 1 m deep in different areas of the planting site. A hard layer within 50 - 60 cm of the surface will adversely affect root penetration and water movement. In these situations chisel ploughing or sub-soiling is required to break up these compacted areas. Sub-soiling is most effective when the soil is dry so that it will shatter, usually during August. Do it in the year before planting and do it in both directions if possible.

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Soil Type and Depth

There is no exact soil type for best apple production. It would be safe to assume that the soil should be at least 1 m deep with few surface stones or hidden boulders. Successful orchard soils may range from sand to clay types. There are advantages and disadvantages of all soil types. Avoid droughty soils and eroded soils with no distinct horizons between topsoil and subsoil.

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Organic Matter

Organic matter (o.m.) is the material left behind after crop residue is broken down by microbial or chemical action. It is important for: improving soil structure, workability, a home for beneficial microbes, improving water holding capacity, improving nutrient supply within the soil. Organic matter determination is available as part of soil analysis upon request. If organic matter is low (less than 2.0 %) it should be improved by ploughing down organic matter such as manure or planting a crop to produce organic matter. Choose a crop that is not a host for nematodes such as those listed below.

SEEDING RATE	
Cover Crop	**Kg/ha**
Annual Rye Grass	20 - 30
Sordan 79	15 - 20
Perennial Rye Grass	10 - 15
Tall Fescue	22
Wheat	100 - 130
Barley	80 - 160

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Soil Nutrient Levels and pH

A soil sample should be taken well in advance of planting so that nutrient and pH adjustments can be made and incorporated before planting. Fertilizer application rates recommended pre-plant should only be determined from a thorough and complete soil analysis. A list of accredited soil testing labs is available at all OMAFRA Field Offices.For additional reading on soil nutrition, consult Best Management Practices manual - "Nutrient Management".

To take a soil sample, scrape away the surface 2 cm of soil. Using a soil probe or shovel, collect a sample from 2.5 - 30 cm (1 - 12 inch) depth. In a 4 hectare orchard, a minimum of 15 subsamples should be mixed together and a handful of soil sent to the lab for analysis. Restrict the area sampled to a uniform soil type or condition within the orchard. If several distinctly different soil types, soil textures, drainage conditions, or crop histories, exist in the orchard, they should be sampled separately.

To avoid micronutrient contamination of samples, do not use galvanized tools or containers for sampling.

The pH of a soil is a measure of its acidity. The target pH before establishing a new apple orchard is **6.5 on sandy soil and 6.0 on clay soils.** If pH is below that range lime is required. The type and amount of lime required will be determined on the soil report.Prior to planting is the only time elements such as phosphorus, boron and lime for pH adjustment can efficiently be worked into the soil. Nutrient levels in the topsoil considered to be adequate for orchard establishment are:

SOIL TEST VALUES	Concentration in parts per million (ppm)
Phosphorous (P)	12 - 20 ppm
Potassium (K)	120 - 150 ppm
Magnesium (Mg)	100 - 250 ppm
Calcium (Ca)	1000 - 5000 ppm
Boron (B)	0.6 - 1.2 ppm
Zinc (Zn)	No valid values
Iron (Fe)	No valid value
Manganese (Mn)	No valid value
Sulphur (S)	No valid values
Copper (Cu)	No valid values
Cation Exchange Capacity (CEC)	8 -25 Milliequivalents/100 g dry soil *(Directly related to amount of clay and organic matter in the soil)*
Base Saturation:	Mg 12 - 15% Ca 65 - 75% K 2 - 4%

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Nematodes

Whether in a replant situation or planting new ground, a soil diagnostic sample to detect the presence of nematodes (microscopic threadlike worms that live in the water film in the soil) should always be taken the year before planting. Nematodes in the soil feed on plant roots and have the capability of setting root and tree growth back significantly. Often the trees do not recover. Nematodes are of greatest concern in sand and sandy loam soils and may not be a problem on heavier clays. Information on sampling procedures and diagnostic services is available from all OMAFRA field offices. Instructions for taking and submitting a soil sample for nematode analysis can be found in OMAFRA Factsheet, "Soil and Root Sampling for Nematode Analysis", Agdex 628.

In Ontario,

the nematode of concern when establishing

a new apple orchard is the

Root Lesion (*Pratylenchus penetrans*).

If the number of root lesion nematodes

are over 1000/kg of soil

control is required.

Other nematode species such as **Spiral, Stunt**, and **Pin** feed mostly on grass roots and do not significantly affect tree growth. The **Dagger** nematode can be a problem if viruses are present. Populations over *50/kg of soil* deserve consideration. For more details on nematodes and their control consult factsheet, "Nematode Management for Ontario Orchards", Agdex 206/628.

Where required, fumigation should be done the fall before planting. Many growers

are now making use of a deep shank fumigator and fumigating only tree planting strips. Your local chemical supplier will have information on the availability of fumigation services. Where nematode populations are moderately high, keeping the site fallow and free from all weeds and grass cover for one growing season with repeated cultivation often drops the nematode levels to below the need for chemical control. If you are fumigating, correct preparation of the soil to break up clods and sods is important to ensure satisfactory dispersion of the nematicide. Soil that is not in fine enough division will allow populations of nematodes to escape control. The result is less than satisfactory control for the money spent.

BECAUSE PROPER SITE PREPARATION IS SO IMPORTANT

THERE SHOULD BE NO HURRY TO PLANT AN ORCHARD

ON A REPLANT SITE OR ANY OTHER SITE.

TAKE THE TIME TO

PROPERLY CONDITION THE SOIL BEFORE PLANTING.

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Irrigation

Tree establishment and development early in the life of the orchard is highly dependent on available soil moisture. Different soils vary in their ability to store water. A well structured clay loam soil can store more water available for tree growth than a sandy soil. Soils that have adequate moisture available throughout the growing season are likely to establish better trees, grow more fruit bearing shoots, initiate more and healthier fruit buds and produce larger, better keeping apples.

Each mature apple tree on fully dwarfing rootstock may require up to 36 litres of water per day in July and August applied with a trickle irrigation system. Irrigation can influence the individual sizes of fruit in the orchard, and have a positive effect on return bloom the following year. Both of these crop characteristics can translate into more bins filled and better dollar return on an annual basis to the grower.

Timely irrigation which maintains adequate soil moisture will delay the formation of terminal buds towards the end of the season. This allows enough time for new growth to mature and harden off properly for the coming winter. Trees suffering from drought stress will form terminal buds earlier at the expense of extension growth and proper winter hardiness. Under drought stress phytosynthesis becomes the primary function. Water will move from the bark and fruit into the leaves. A tree is out of available moisture long before its leaves wilt.

Available Soil Moisture

The ideal situation is to have a continual adequate supply available all through the season so growth is not interrupted and the tree is not stressed. A level of 40 - 50% available soil moisture (A.S.M.) is considered adequate for all soil types. With trickle irrigation system the A.S.M. under the emitters is maintained at 85 - 90%. With sprinkler systems the A.S.M. can drop to 50% without affecting yield. This level will be easy to maintain at some times and not at others. In some soil types it will require constant monitoring and careful application.

Monitoring Available Soil Moisture

Available soil moisture can be determined by feel. Fine textured soils (silt and clay

loams), which can be cupped in the hand and gently squeezed into a ball that holds together, probably contains up to 50% A.S.M. A ball which is somewhat crumbly, although holds together with pressure, may contain only 30 to 40% A.S.M. or less.

A device called a **tensiometer** can also be useful. This instrument measures the "pull" of water out of a sealed tube through a porous ceramic tip planted at a specific depth. A vacuum gauge measures the vacuum created as the soil draws water out of the tube. A chart will compare dial readings to the available soil moisture for each soil type.

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Frost Protection

By choosing an irrigation system that sprinkles water onto the crop canopy, a grower may be able to control frost in the spring. Frost control can be achieved by continually watering until the threat of freezing injury is over the following morning. As water freezes it liberates heat, even though blossoms may be covered in ice, as long as the ice is kept wet by water, heat is available to protect the blossoms. A system which is set up to apply 4 mm of water per hour is usually sufficient to frost protect apple blossoms down to about -6/ C.

Care must be taken to adequately protect from diseases such as apple scab and fireblight where water is used for frost protection.

Fertigation

THE BENEFITS OF FERTIGATION

MAY NOT JUSTIFY

THE EXTRA COST

AND MANAGEMENT REQUIRED.

The use of trickle irrigation systems to apply prescribed amounts of the macronutrients, nitrogen (N) and potassium (K) is commonly called fertigation. This approach to fertilizing is being cautiously investigated by some growers. For more information on the principles and practises of fertigation consult, "Best Management Practices - Irrigation Management".

With fertigation, instead of applying the required amount of N as a single banded application around the drip line of each tree or in the herbicide strip, 1/3 of the N requirement per tree is injected as a single dose in early April before the trees leaf out. This is done to stimulate early vegetative growth in the spring. Active root growth starts before any obvious bud development in the tree canopy. Total recommended rates of N and K applied as dry fertilizer can be reduced by about 50% with fertigation. This method of feeding orchard trees should be carefully monitored by leaf analysis.

Soil acidification occurs rapidly below the emitters where ammonium nitrate is used as the nitrogen source. The remaining 2/3 of the N requirement is applied in equal amounts with subsequent irrigation in May and June, but not thereafter. Termination of N application in June is required to slow vegetative growth and promote hardening off for winter. Calcium nitrate is the preferred N source for fertigation of tree fruits because soil acidification occurs more slowly.

When applying potassium (K) using fertigation, instead of applying the total requirement per tree as a single banded application in the spring, K is injected in equal amounts with each irrigation in July and August. The delayed application of K relative to N is to enhance fruit colour, winter hardiness, tree growth and disease resistance during the latter half of the growing season.

Fertigation is not used for:

Phosphorous (P): Ontario orchard soils usually have sufficient levels of phosphorous and apple trees normally do not have any trouble extracting adequate amounts.

Magnesium (Mg) and Calcium (Ca): Where needed, are best applied as soil amendments or as foliar sprays.

Micronutrients (e.g. boron, manganese, iron, zinc): Where needed, are best applied as soil amendments or as foliar sprays.

Each fertigation application should be part of a scheduled irrigation, and is best conducted near the end of each irrigation cycle to avoid leaching of nutrients below the main rooting zone. The lines must be flushed immediately after each fertigation to prevent plugging of the emitters.

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Establishing the High Density Supported Apple Orchard

Part 2: Choosing Trees for Planting

Revised: January 1998
Prepared by: The Apple Team, OMAFRA
Editor: Ken Wilson, OMAFRA, Clarksburg

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Nursery Tree Quality and Sources

One of the biggest mistakes apple growers make when switching to higher density supported systems is not starting with the proper tree. Without a proper tree, the advantages of a higher density system are greatly reduced. Trees that cannot produce fruit immediately will greatly increase the carrying costs of a system that is initially quite expensive. This delay can be enough to destroy the economic advantage of the higher density supported systems and discourage growers who are trying this approach for the first time. It is recommended that trees be ordered at least two years in advance of planting. This way there is a better chance of getting the cultivar/rootstock and quality of tree you want.

Two Year Feathered Tree

This tree is considered to be the ideal nursery tree and will cost more than a conventional one-year whip. Is it worth it to pay the higher price for the ideal tree? The answer is unequivocally "yes", if you combine that expenditure with the quality orchard-management practices needed to get the most from a high-density planting. An ideal tree poorly cared for will not justify its cost. A high quality tree in a properly managed orchard will return its cost many times over.

Definitions

Feathers - a lateral shoot produced in the same year as the leader.

Branch - a lateral shoot that is one or more years younger than the leader.

The quality of the tree used in high density supported systems **cannot be over emphasized**. The tree has to be specially prepared to produce fruit immediately

at a young age. The ideal apple tree for planting should come with a canopy structure already in place including fruit buds (Fig. 1).

Such a tree should have a dominant central axis, or leader, and should be 1.7 - 2 m (5 - 6 ft.) in height, including roots. It should have 5 to 7 good quality lateral shoots (feathers) of nearly equal diameter. The first lateral should originate at least 60 cm (24 in.) above where the soil surface of the orchard will be after planting. The laterals (feathers) should be well-distributed, both around the leader as well as along the leader, so that they are properly positioned to become permanent scaffold limbs as the tree develops. A good-quality lateral shoot or feather should be 15 - 20 cm in length at the absolute minimum, and preferably longer.

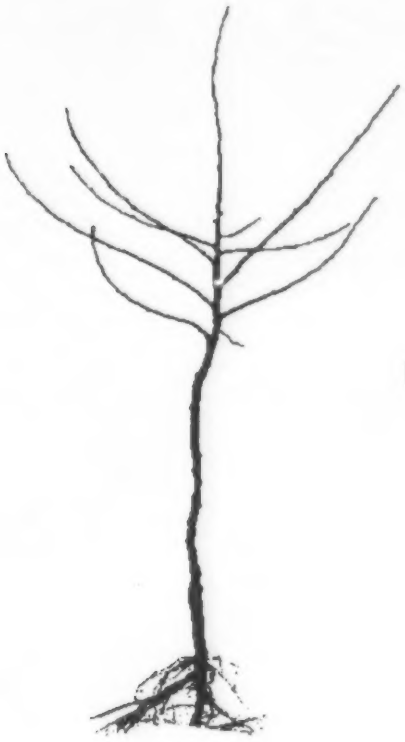

Fig. 1

Example of well feathered

2 year tree

One Year Whip

The one year whip will not work as effectively as a two year feathered tree. A 2 year old branched tree is even less acceptable in high density systems. Where "whips" are chosen, the minimum caliper (diameter of tree 2 - 5 cm above bud union) that should be accepted is 2 inch. With whips the technique of bagging will help improve their development.

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Planting Density

Until more growers master high density supported systems it is suggested that tree densities of ***1500 - 1800 trees per hectare (600 - 720 trees per acre)*** be the preferred introductory system. The in-the-row spacing between trees is suggested to be perhaps 1.5 m (5 ft.) although 1.2 m (4 ft.) or 1.8 m (6 ft.) could be

accommodated quite well depending on cultivar, rootstock, soil strength and support system. Between the row spacing may well be dictated by equipment availability, but 3.6 m - 4.3 m (12 - 14 ft.) is suggested.

TREES PER ACRE AT VARIOUS SPACINGS

Distance between rows of trees (feet)	Distance between trees in the same row (feet)				
	4	5	6	7	8
9	1210	968	807	691	605
10	1089	871	726	622	545
11	990	792	660	566	495
12	908	726	605	519	454
13	838	670	558	479	419
14	778	622	519	444	389
15	726	581	484	415	363
16	681	545	454	389	340

The higher the final height of the tree the greater the space that must be left between rows to maximize light interception. For first time attempts with the Slender Spindle System (to be described later), a spacing of 5 ft. between trees and 12 ft. between rows has worked well in other areas of Canada. For the Vertical Axis System (to be described later) a spacing of 5 ft. x 14 ft. has worked well.

For maximum light interception the distance between rows is considered to be 1.3 - 1.5 times the final height of the tree.

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Rootstock Options

There may be several rootstock options possible where higher density supported orchards are concerned. Rootstocks for this type of planting must: control tree size, reduce vigour and induce precocity (early fruiting). M.9 is considered to be the preferred rootstock to start with because of its proven adaptability to high density plantings. Other rootstocks such as: Ottawa 3 (O.3), Budagovsky 9 (B.9), Poland 2 (P.2), and MARK may also be adaptable, but experimentation should not be attempted until M.9 is mastered.

Malling 9 (M.9) produces trees 20-35% the size of standard trees, is very precocious and very productive. Because its roots are brittle and break easily, anchorage is poor. Trees on M.9 should not be grown on light textured, sandy soils, without supplemental irrigation. It is tolerant of collar rot and does well on heavier soils where drainage is adequate. However, M.9 is susceptible to fireblight and woolly apple aphid. Many virus free M.9 sub-clones have been developed by heat treatment to ease propagation in the nursery and increase tree vigour in the orchard. Caution should be exercised if this rootstock is planted in the colder growing districts of Ontario, or on sites which frequently lack snow cover.

M.26 may also be modified for a high density supported system with some cultivars particularly spur types. M.26 is strongly influenced by

soil conditions. M.26 is not drought-tolerant and will easily "runt-out" on light, sandy soils without supplemental irrigation. It will do well on intermediate or heavier textured soils if drainage is adequate. While moderately resistant to collar rot, M.26 will not perform satisfactorily on poorly-drained sites. M.26 is very susceptible to fire blight and woolly apple aphid.

Rootstocks for Trial Use

MARK is an open pollinated seedling of M.9 which was introduced by Michigan State University. It is precocious and has a yield efficiency similar to M.9. MARK performs well in heavier, wetter soils and is resistant to collar rot. It is susceptible to fire blight and woolly apple aphids. Heavy cropping in the early years may stunt growth and fruit size later on. Rootstock trials have shown that MARK often develops soil line swellings, and fine roots grow from the swollen area. This swelling may disrupt movement of moisture and nutrients from the roots to the top of the tree. This soil-line swelling does not occur as much in heavier, wetter soils where the climate is cool and moist. The problem is worse in hot, dry, arid growing conditions. MARK must always be supported to reduce this problem.

In the colder growing areas of Ontario, the greater winter hardiness of rootstocks 0ttawa 3, Budagovsky 9 and Polish 2 could help to reduce risk of tree loss in high density plantings.

Ottawa 3 (O.3) is a precocious, winter hardy rootstock bred in Ottawa, from a cross of M.9 with the hardy crabapple cultivar "Robin". Ottawa 3 produces a tree between M.9 and M.26 in size. Difficulty in propagation of 0.3 in the stoolbed has hurt its availability and popularity. This rootstock is resistant to collar rot but is susceptible to fireblight and woolly apple aphid.

B.9 is one of the hardy Budagovsky rootstock series produced at the Michurin College of Horticulture, in Russia. B.9 displays dwarfing similar to M.9, but is more winter hardy. B.9 may be susceptible to fire blight, and woolly apple aphids, but has greater resistance to collar rot than M.9.

P.2 is a Polish rootstock with similar precocity and yield potential of M.9. Its winter hardiness is comparable to that of 0.3 and B.9. P.2 is resistant to collar rot, but is susceptible to fire blight and woolly apple aphids. It does not produce root suckers, has few burr knots, but does not propagate easily.

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Cultivar Selection

The choice of cultivars for future plantings **WILL BE DIFFICULT**. The biggest single advantage to high density supported systems is the ability to bring a cultivar into early production. This allows the initial cost of the planting to be recovered earlier and allows growers to take advantage of new cultivars commanding higher prices on the market. To plant a high density supported orchard to a cultivar with poor market potential and returns may defeat the advantages of using intensive production systems.

Of the traditionally grown cultivars in Ontario, the semi-spurs, e.g. ***Empire*** and ***Idared*** are well suited to higher density systems as are ***spur types of McIntosh and Delicious***. Non-spur types pose more of a concern because of vigour but can be managed.

When establishing new plantings of McIntosh and Delicious only the ***best quality red strains*** of these cultivars should be used. These two cultivars should be grown in regions where best quality can be achieved. McIntosh should be confined to areas of the province that are capable of producing the well coloured firm fruit that the market demands.

The new cultivars on the scene such as ***Braeburn, Elstar, Fuji, Gala*** and ***Jonagold,*** hold promise for some growers if they can get into immediate production. Some apple marketers in Ontario have indicated that growers should not get left behind on these new cultivars if our market is to resist imports. However, regardless of cultivar, count size apples are slowly dominating the Ontario market. Growers should respond to this demand by growing the size(s) and quality the market wants. All growers require a cultivar mix that can be harvested sequentially at the proper time. Consult your marketer before planting any cultivar(s).

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Pollination

Cropping, and especially early cropping, is an essential management factor. Every attempt must be made to assure fruit is produced. To allow for effective pollination, a minimum of 1 in 10 trees should be a compatible pollen source. Usually, pollenizer trees are evenly dispersed through the orchard or in solid rows in such a manner that no tree is more than 30 m (100 ft.) from a pollenizer tree.

An effective pollenizing cultivar is one that is a consistent bloomer every year, and has a large amount of viable pollen. It should bloom at the same time as the cultivar to be pollinated. In the case of triploid cultivars (e.g. Crispin, Jonagold) that do not have viable pollen, two pollenizers are required to get acceptable yields of the pollenizers.

The presence of 3 cultivars allows the pollen requirements of all 3 to be met even though one has nothing viable to contribute. Some growers are interested in crabapple pollenizers. Consult factsheet "Crabapple Pollenizers for Apples" - Agdex 211/21, for further details.

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Establishing the High Density Supported Apple Orchard

Part 3: Choosing a Tree Training System

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Basics of Supported Tree Training Systems

M.9 will require tree support for the life of the planting. **In fact, all trees on any rootstock in a high density system need tree support**. This can be accomplished with several different structures.

There are 3 supported training systems which have been most commonly used by apple growers in Ontario:

1. *Slender spindle* (SS)
2. *Vertical axis (VA)*
3. *Trellis*

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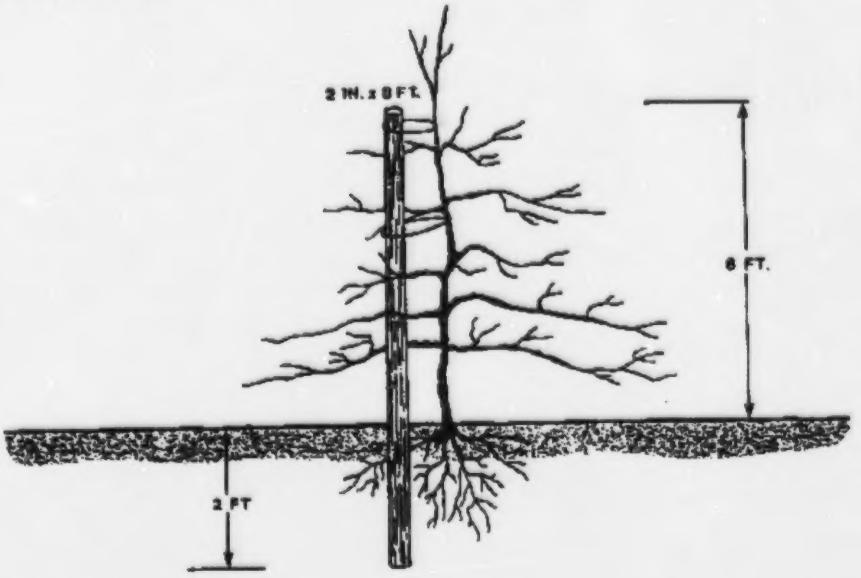
Slender Spindle System

This is the system preferred by growers who wish to work exclusively from the ground and are not confident in building wire support systems. The ***slender spindle (SS)*** consists of an individual support post at every tree

Fig. 2 **Slender Spindle Support System** (taken from Support Systems for High-Density Orchards, K. B. van Dalfsen, B.C. Ministry of Agriculture and Fisheries, 1989)



The post should be 2.4 - 3 m in length and of pressure-treated wood, concrete or metal to ensure it lasts the life of the orchard (perhaps 12 - 18 years). A diameter of 4 - 6 cm is preferred, since risk of frost heaving increases with larger diameters. The depth of the post in the ground should be 60 - 90 cm for stability leaving 1.5 to 2.5 m above ground.

The tree is trained to a slender bell, or pear shape with the bottom whirl of branches acting as a permanent fruiting table. The leader and top of the tree is kept quite weak to contain height.

Tree height does not exceed 2 - 2.5 m.

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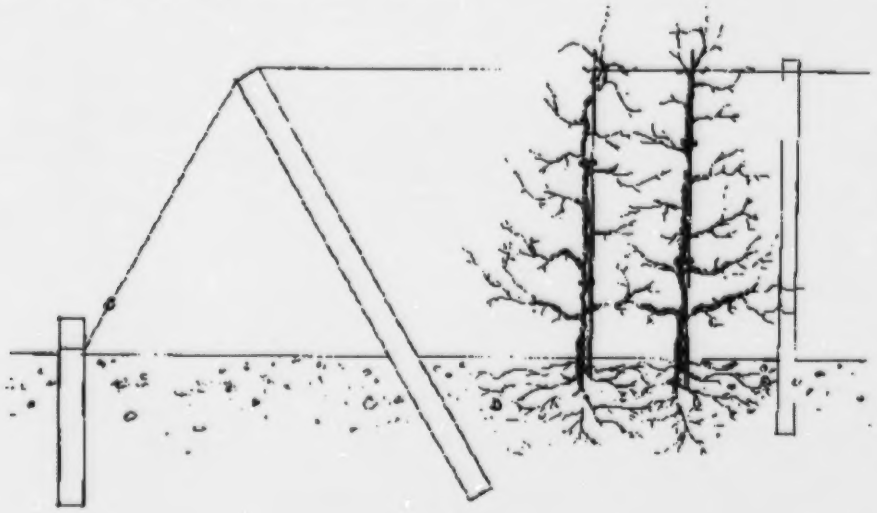
Vertical Axis System

The ***vertical axis*** (VA) system has been touted by some growers as the next logical step from free standing central leader trees to high density supported systems. The main reason cited is the great similarities between the systems and the low emphasis on limb manipulation by tying. There are ladders used in picking, but with a flat tree wall at ladder height it is quite fast and simple to manage ladders.

Even though the VA system is one of the taller systems used in high density supported systems, there is still a critical need for lower limb development. These lower limbs will form a fruiting table yielding perhaps 60% of the crop and must be established before the trees should be allowed to grow taller. Proper development of the bottoms of the tree will allow 75% or more of the fruit to be picked from the ground. Cultivars that have a high requirement for light (e.g. McIntosh) are well suited to this system.

Fig. 3 **Vertical Axis Support System**

VA systems allow trees to grow taller than SS systems. The system basically consists of one or more high tensile steel wire(s) drawn tight and supported 2 - 3 m above the ground by a series of in-line posts spaced 9 to 15 m apart.



Individual trees in the row are supported by vertical leader supports that reach up to the top support wire. The tree consists of a conical, or "Christmas tree" shape and grown up to 3.5 - 4.0 m tall. The leader is not pruned until the tree reaches its full height. Side branches on the leader are renewed on a periodic basis.

The VA support system is somewhat more complex than the SS to install. It does require a high level of skill to build the support system and be sure it is adequate to hold the trees and crop load. A post failure in this system can result in the loss of several trees. More information on building the VA support system is available from the Apple Team.

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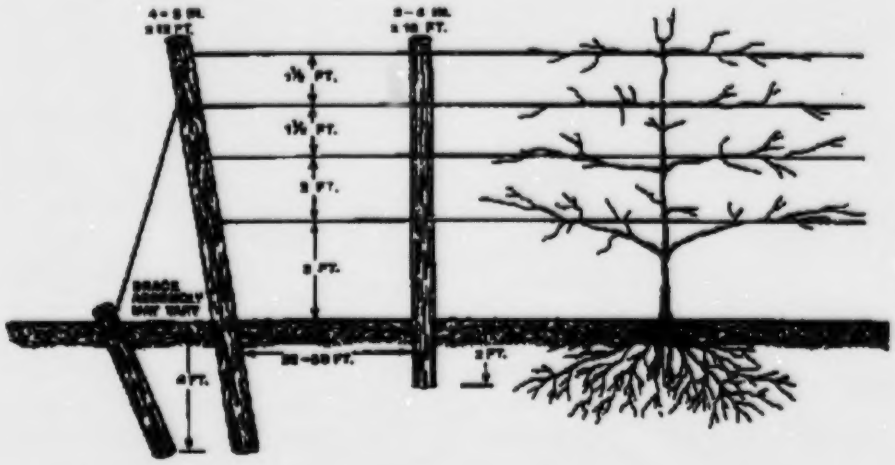
Trellis Systems

The various *trellis* systems require a similar set up as that described above for VA. The number of wires used can range from 3 - 5 in simple vertical trellises and up to 10 - 12 for a *tatura* or Y-trellis. Unlike the VA there is no support along side each individual tree. Instead, branches are trained horizontally along the wires.

Fig.4 **Trellis Support System** (taken from Support Systems for High-Density Orchards, by K. B. van Dalfsen, B.C. Ministry of Agriculture and Fisheries, 1989)



If you are planting a trellis system it would be wise to follow the specific guidelines for whichever system you select. The key problems of trellis systems are varieties with excessive vigorous or strong rootstocks that result in excessive pruning to contain the tree. Also, trellis systems support the total weight of the crop load and, as a result, must be exceptionally sturdy with posts for wire support located every few trees in the row (much closer, than the VA system).

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Comparing the Systems

In terms of **installation costs** the VA is slightly less expensive than the SS which is slightly less expensive than a trellis system. This varies depending on the availability of supplies to build the various systems. A one-year whip can be used in *trellis* and VA systems. Two year feathered trees are preferred for VA and essential for SS plantings.

As stated earlier, the advantage of all three systems, when planted to appropriate cultivars and dwarfing rootstocks, is **early production (precocity)**. These are labour efficient since all can be worked from the ground.

Of the three systems, the *trellis* system probably requires the most **pruning** (winter and summer) to maintain horizontal scaffolds trained to the wire support. The SS would be next in labour requirements to train the tree, the VA has the least labour costs to train and manage. Care must be taken when using pneumatic or back-pack operated pruners and loppers on wire systems, to avoid damaging the wire(s).

Harvesting may also be challenging in wire systems because of the solid barrier nature of the tree row.

The economics of production between the SS and the VA do not differ significantly. It is a personal preference that steers growers to one system or the other. A technical document titled, Cost of Production - High Density Supported Apple Orchard is available from the Apple Team.

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Establishing the High Density Supported Apple Orchard

Part 4: Planting the High Density Orchard

Revised: January 1998
Prepared by: The Apple Team, OMAFRA
Editor: Ken Wilson, OMAFRA, Clarksburg

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1. Planting Date
2. Orchard Row Direction
3. Planting the Tree
4. Pruning at Planting: SS and VA
5. For more information....

Planting Date

Plant as early as possible in the spring. This is a much underrated key to early tree establishment and maximum growth in the first year. Mark out your rows as soon as possible in the spring and arrange to have your trees on site in order to plant as soon as conditions permit. Studies have shown that along with tree quality early planting has a greater effect on early growth than even irrigation and fertilization. Keep track of soil temperatures at planting depth. New roots will form when soil temperatures reach 7^0C, and existing roots start to grow at temperatures lower than 7^0C.

Fall planting can be beneficial on well-prepared sites in Southern Ontario. Trees must be fully dormant, and planting should be completed as early as possible to allow for root establishment.

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Orchard Row Direction

It is preferable to have the rows running north-south where possible. This row orientation is best for achieving the maximum light utilization that is so important in high density plantings. Only consider another orientation if north-south rows would result in air movement being blocked or reduced or if there is machinery safety factor to consider on slopes.

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Planting the Tree

Many methods of planting can be used:

1. a shovel
2. an auger

3. tree planter

The ***tree planter*** is considered the best method where all of its requirements for use can be met. With tree planters trees can be planted very quickly which is important for high density plantings in order to capture the often short span of ideal planting time.

A drawback to tree planters are that they require almost seedbed preplant preparation of the ground, in order to ensure good contact between the soil and the roots, especially in wet ground. They also require that the tree height be adjusted by hand immediately after planting which may cause some root breakage.

Augers avoid these drawbacks and do a satisfactory job when used in light and medium soils. In heavier soils, however, glazing on the sides of the hole can occur. This can seriously restrict future root growth unless the auger is modified to fracture the side of the hole to prevent pot sides. When augers are used it is important that they make a hole at least 50 cm (20 in) in diameter to prevent curling of roots. A double auger is a piece of equipment which makes a planting hole and a post hole at the same time.

Shovel planting is another option. It does a very good job with few drawbacks, but it is slower. Regardless of the method used, avoid digging the planting hole too small or deep. Excessively deep holes that have to be backfilled before the tree is planted tend to settle, lowering the bud union too close to the ground.

Make sure the roots are never allowed to dry out. Keep trees protected from wind and sun, and totally covered with a plastic sheet or tarp when moving them. For immediate planting, soak the roots in a barrel of clean water for no more than 6 to 12 hours before planting.

If the trees must be held, make sure the roots are kept moist at all times and the tops do not dry out. A cold storage is excellent but make sure it is ***free of any ethylene gas*** from previously stored apples that can damage the new trees. Healing in the roots is preferred to common barn storage. Finally, it is imperative that the trees have not broken dormancy before planting.

Before planting the trees, trim off any excessively long roots and any broken, damaged, or dead root ends. Place the tree with the side where the bud was inserted away from the prevailing wind and away from the support stake.

The tree should be planted at a depth that will leave the bud union 8 - 10 cm (3 - 4 in.) above the ground after settling of the soil occurs.

Any lower and the dwarfing effect of the rootstock will be lost. When planting try to control the planting height precisely. Avoid pulling the tree up to the proper height after planting. M.9 roots are very brittle and break easily when the tree is pulled up.

Position the tree straight for VA and trellis plantings, or angled slightly away from the supporting system for SS. Make sure, regardless of the planting method, that the loose soil is tramped firmly after planting. This ensures good soil-to-root contact and helps to eliminate air pockets.

After planting make sure the tree receives two soakings with water early in its life, either by rain or irrigation. This should totally eliminate air pockets. A liquid transplant fertilizer, e.g. 20-20-20, should be applied immediately after planting in the first watering. Mix this fertilizer according to the label and apply this drench over the root area of the tree. In sandy soil this solution often spreads over a large area and does not penetrate to the roots.

Growers have been very successful **injecting the fertilizer solution** into the area of the tree roots with home made devices. A probe (often 2 in. copper pipe x 1 m long) plumbed to a sprayer, can be pushed into the ground under the tree to soak the root areas. When the probe is withdrawn, the entry hole is closed by stepping on it.

If granular **fertilizer** has not previously been applied for the first year, apply 60 - 100 g of 34-0-0, two weeks after planting. Band it around each tree in a circle of at least 30 cm radius. Applications should be made before cultivation or irrigation in order to incorporate the nutrients for immediate uptake and use

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Pruning at Planting: *SS and VA Training Systems*

Immediately after planting, and while the tree is still dormant, it must be pruned.

!. If you have planted a "whip" make a heading cut at 80 cm from the ground. The leader of the whip once pruned should be bagged to encourage maximum limb development.

Bagging:

Immediately after heading the tree at planting an approximate 50 cm long plastic bag should be placed over the terminal, and secured in place using 2 or 3 twist ties. This will encourage maximum branch initiation. The bag is removed at ½ inch green or before any scorching of new growth occurs (7-14 days).

!. Spur types and weaker whips should be headed slightly lower (70 cm) and vigorous varieties can be left a little higher (90 cm).

!. If you have planted a tree with feathers on it (shoots same age as stem from which they originate), remove all feathers below 60 cm, and any that are too vigorous or have bad angles. Any feathers longer than 40 cm should be cut back by 3 to a of their length. All remaining feathers should be of nearly equal diameter. If you have 4 or more useful feathers remaining, head the leader 20 - 25 cm above the highest useful feather. If you have less than 4 well-spaced feathers remaining, remove them all using a "Dutch cut" (Fig. 5), and handle the tree like a whip. If the feathers are badly located (for instance, all to one side on the stem) they should all be removed with the Dutch Cut.

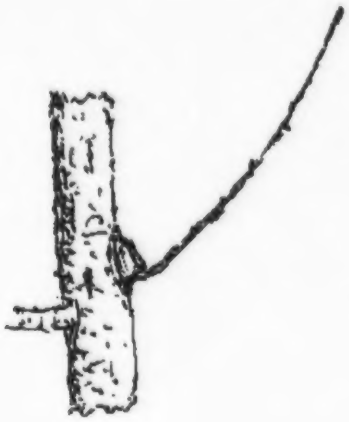

Fig. 5 A **Dutch Cut** (often called a bench cut) is made when a limb is removed on an angle and not flush with the trunk. The cut is close on the top and wide on the bottom to hopefully allow latent buds to grow a usable limb at the location where an unusable one was removed.

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Establishing the High Density Supported Apple Orchard

Part 5: Training High Density Apple Trees

Revised: January 1998
Prepared by: The Apple Team, OMAFRA
Editor: Ken Wilson, OMAFRA, Clarksburg

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    2. 2nd Year
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    4. General Training Comments
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Training the Slender Spindle (SS)

A Slender Spindle tree consists of a moderately strong central leader surrounded by weaker and more or less horizontal lateral branches. The diameter, length and vigour of these branches decreases slightly from the base to the top of the tree. The general appearance is that of a slender bell in which the basal diameter is approximately one half of its total length (height).

In developing the slender spindle tree, the goal should always be to **weaken the growth in the top** of the tree in order to encourage the production of fruiting laterals. As with all training systems you must build the tree one step at a time. A high level of grower skill is required to be successful with SS system.

The **support stake** (post) should be put in place before, at, or immediately after planting so that the new tree can be supported right from the start. Experiences have shown that the stake should be placed 10 - 15 cm from the base of the tree and on the north side, assuming the rows run north to south.

Where **wind** is a consideration, trees should be planted on the downwind side and pulled back to the stake. Tie the tree to the post so that there is about an 8 cm gap between the tree and the post. Any inexpensive tying material can be used as long as it is long lasting. Speciality ties are available.

- High density supported systems require physical support for the life of the planting (perhaps 18 - 20 years). If not already in place, the support system should be put in **immediately** after planting. Do not allow the trees to stand free as this will lengthen the time to establishment and reduce the amount of extension growth possible.
- There are major differences in the growth and fruiting habits of apple cultivars. No single training system will be perfect as a result. As grower experience increases, different systems will prove best for different cultivars.
- The ultimate yield potential of a block will be determined by the size of canopy bearing surface.

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Planting Year (SS)

Leader Development

At 7 - 10 cm (3 - 4 in.) of new growth, select the leader and neatly cut off the 2 or 3 shoots competing with it. There is the option at this point of using the *pinching technique* described under the VA system. If the pinching technique is used it will need to be done several times in the early growing season.

It is very important to emphasize growth in the planting year. Defruit at calyx to allow all trees to establish and make maximum extension growth.

Late July (after terminal bud has set)

On trees with 2 year old lateral branches, tie down all 2 year old branches that are longer than 45 cm to a horizontal position (vigorous varieties such as Northern Spy, should be tied below horizontal).

Tying is an integral part of the SS system. Growers make money by tying to induce fruiting and there is no other way to control extension growth.

If you are not going to tie you do not want this system, proceed to VA.

Limbs that are shorter can be allowed to grow for the first season to get maximum extension growth. Such limbs left to grow, if they grow to 45 cm, should be tied down in mid August, to encourage fruit bud development. This limb positioning slows extension growth and encourages flower bud initiation followed by fruit set.

September

Tie down any vigorous one year old lateral branches longer than 45 cm, or at least do it before bloom the following year. Limbs are usually not tied until they are 40 - 45 cm long. The lower limbs on the tree are not bent as far below horizontal as the limbs that are higher in the tree. This allows for the development of a permanent fruiting table.

The easiest way to remember is to point the branch end toward the base of the next tree trunk in the row. This limb positioning maintains the conical shape of the tree to maximize light interception and utilization.

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2nd Year (SS)

Dormant Pruning

Remove unwanted lateral branches using a "Dutch cut" where you want a replacement limb. If no re-growth is wanted where a limb must be removed, remove with a "flush cut". If the tree is very vigorous, wait until after bloom to remove this limb. Strong growing limbs that have a large diameter and are putting the tree out of balance should be **removed**. Strong growth is never fruiting growth. Even if bent, these limbs are a poor source of fruit and should be removed. Upright shoots and suckers can also be removed with a flush cut at this time.

Leader Management

In the second year, if the leader is weak, you must head it back. If the leader is strong you can "head and bag" or you can bend (do not head) so that the tip points toward the base of the next tree. If you turn the leader down you must tie it back up to the stake in late June of that year.

NOTE:

Where not enough branching has taken place (less than 4) in the planting year, the top should be regrown. When the tree is dormant cut the trunk at a point 45 cm from the ground, and restart the entire tree top. This seems like a drastic measure but high density supported systems require a "busy" tree with lots of branches. To accomplish this, the tree must be build one step at a time.

Late July and September

Proceed as in planting year.

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3rd Year (SS)

Dormant Pruning

If you have enough lateral branches, and the leader is strong, choose a one year old limb as your new leader and remove the original vigorous leader. This zig-zag technique of leader management keeps the leader weak. This prevents the leader from quickly reaching the top of the support stack and allows for maximum limb development lower on the tree. If limb length is too long containment is possible by cutting into 2 year old wood or to a fruit spur on that limb. Never cut to one year wood until you have studied the growth habits of your trees. Most cultivars respond poorly to this cut. If you have selected a replacement leader you must tie the leader back up in June.

If there is not enough branching and the leader is weak, all you can do is head the leader to encourage growth or select a superior one year old branch as a new leader, tie it up and head it back.

If there is not enough branching and the leader is strong, you can "head and bag" or bend the leader by pointing it down to weaken it. Remove unwanted lateral branches such as strong limbs (with a Dutch Cut) as described for 2nd year. Remove unwanted vertical shoots and suckers with a clean cut.

Late July and September

Proceed as in previous years.

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General Tree Training Comments (SS)

Vigour control in the slender spindle system is largely dependent upon limb positioning and early cropping. In general, the more horizontal the orientation given to a limb the less the extension growth that will occur. This limb will be influenced to form fruit buds and crop sooner than an unmanaged limb. Remember, once tied to the horizontal position, extension growth on the limb is virtually stopped. Limbs positioned horizontally before they have set a terminal bud will behave poorly and try to regrow vertically from the tip.

The material used for tying should be inexpensive, easy to knot and biodegradable by the following season. Tomato tying twine or other jute twines have been used successfully. Tree weights at first glance appear very handy for limb positioning, but accurate weight placement on the first try is difficult. Readjustment of the weights after the limb accepts the load is very time consuming.

The simplest way of tying limbs is to use a separate string for each limb tying back to the base of the post or tree. Be sure to use a loose, non-tightening loop (Fig. 6) when tying down limbs and do not double wrap the limb with the string as strangulation is possible.

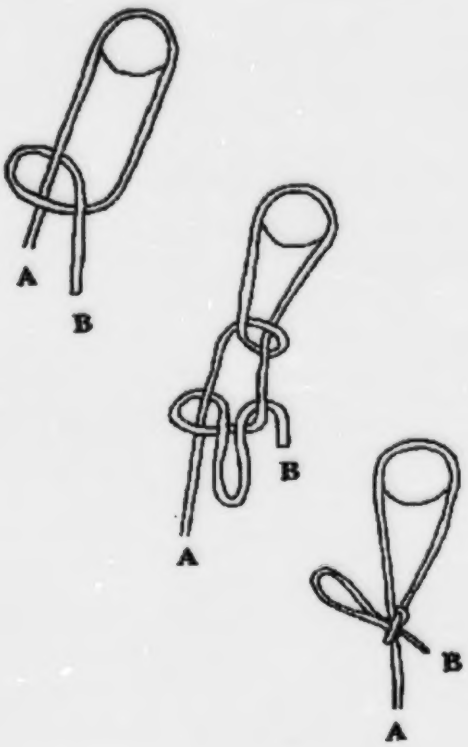

Fig.6 **Tree Training Knot**

Step 1: Secure end **A** to stake or tree trunk. Pass string over limb to be pulled down and pull to correct angle. Leave at least a 5 cm loop in string before starting knot.

Step 2: Before proceeding pull sharply on **B** to transfer the loop from the **B** end to the **A** line.

Step 3: Completed knot

In post systems, another method to consider uses a continuous string going from a galvanized nail on the lower backside of the stake to a limb then back to the nail (double wrapped on the nail) then on to the next limb and so on, until all limbs are secured. Then the knot is tied off at the last limb.

Rubber bands have been used to position first year shoots. Loop the band through itself around the leader and slip the end over the shoot to be pulled down. Take care that the end of the shoot does not go too low.

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Training the Vertical Axis (VA)

In the VA system a strong unheaded leader is encouraged to grow until it reaches 3 - 3.6 m (10 - 12 ft.) from the ground. This central axis forms a central pivot around which lateral branches radiate to form a narrow cylinder of fruit bearing wood. The diameter of the branches should gradually decrease to the top of the tree, and they should always be smaller than the trunk where located.

There should be a lessening in the length of the laterals from the bottom to the top, this results in a slender conical shaped tree. The distance between the branches should be less towards the top of the tree in order to allow for maximum light penetration.

Very little tying is practised with this system. There is more room for error in the VA system before a problem results. The level of grower skill required to be successful is less than the SS system.

The VA system can be as productive as the SS system because of the increased bearing surface. The orchard at maturity will form a tree wall as opposed to individual trees. As with all training systems you must build the tree one step at a time.

- High density supported systems require physical support for the life of the planting (perhaps 18 - 20 years). If not already in place, the support system should be put in **immediately** after planting. Do not allow the trees to stand free as this will lengthen the time to establishment and reduce the amount of extension growth possible.
- There are major differences in the growth and fruiting habits of apple cultivars. No single training system will be perfect as a result. As grower experience increases, different systems will prove best for different cultivars.
- The ultimate yield potential of a block will be determined by the size of canopy bearing surface.

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Planting Year (VA)

Leader Development

With the VA system the leader is pruned at planting and not touched again. In the early life of the orchard a zone identified as the production table must be established in each tree. The leader should be maintained in its vertical growth during the early age of the tree (especially years 1 to 8). This is accomplished by attaching the leader to a pole.

It is very important to emphasize growth in the planting year. Consult "Chapter 6: Tips for Successful Establishment" for growth enhancement suggestions. Defruit at calyx to allow all the trees to establish and make maximum extension growth.

Pinching Technique

As soon as the new side shoots from the leader heading cut are 7 - 10 cm (3 - 4 inches) long, pinch out the apical bud on the 2 or 3 competing shoots and leave the leader undisturbed. This manoeuvre should be repeated every 14 days until the end of July.

The first tier of limbs should be allowed to grow at an angle above horizontal (45E) to make them vigorous and strong. Do not tie these limbs down. Very little tying is done in VA systems. Limbs below 60 cm from the ground should be removed. Secure leader repeatedly to ensure maximum extension growth.

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2nd Year (VA)

Dormant Pruning

Keep pruning to a minimum to reduce vigour. Remove upright shoots and overpowering limbs only. Remove unwanted lateral branches using a "Dutch cut" where you want a replacement limb. Strong growing limbs should be removed as they put the tree out of balance and strong wood is never fruiting wood. If no re-growth is wanted where a limb must be removed, remove with a "flush cut" after bloom. Where vigour is excessive do not remove any limbs until after they have fruited. Only summer pruning should be done in vigorous trees.

Leader Management

The leader is usually not pruned or headed to encourage maximum extension growth. This is the main feature that distinguishes VA from other training systems. However, in the second year if leader is weak you must head it back. Side shoots that compete with the leader should have the apical bud pinched (see Pinching Technique) out every 14 days to keep them weak and encourage wide angle crotches to form below. This operation begins when the competing shoots are 7 - 10 cm long. This technique does not require a heading cut to make it work.

NOTE

Where not enough branching has taken place (less than 4) in the planting year, the top should be regrown. When the tree is dormant cut the trunk at a point 45 cm from the ground, and restart the entire tree top. This seems like a drastic measure but high density supported systems require a "busy" tree with lots of branches. To accomplish this, the tree must be build one step at a time.

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3rd Year (VA)

Dormant Prune

Same as 2nd Year. Continue with the pinching technique on apical bud competition if they can be reached from the ground. Secure leader to support system. As the planting gets older it will become necessary to thin out the limbs. This thinning is done dormant and consists of removing the strongest limbs by renewal cuts (Dutch Cuts), but leaving the bottom fruiting table intact. Don't begin to thin out the bottom of the tree until fruit is higher in the tree. Remember that

fruit controls growth, whereas, pruning encourages growth. You must have abundant fruit present or regrowth will be tremendous and costly. At maturity, summer pruning may be required for some cultivars where the uprights are removed to allow for greater light exposure.

Fruit also controls tree height. The VA system should not be headed until fruit is at the top of the tree, and the leader has been pulled down with the weight of the fruit. At this point, perhaps year 5 or beyond, the top can be reduced in size to allow better light exposure to the lower limbs.

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Training the Trellis Systems

There are many different kinds of trellis systems being used world wide. Some are extremely formal in design and require detailed timely management. Trellis systems involve the positioning of limbs along the supporting wires. This positioning can be done at any time the work load permits. Horizontal positioning is the most productive and limbs that are growing into the travel row can be either bent back in line or removed. Pruning is kept to a minimum to reduce vigour. The trees at planting are normally headed 15 cm (6 in.) above the bottom wire. Shoot growth is allowed to proceed unmanipulated until mid-July. At this time shoots are secured to the support lattice using quick, inexpensive tie materials. Upright shoots and water sprouts are removed during August to minimize regrowth and vigour. Completion of every layer is important in a trellis system. Do not allow a strong leader to reach the top of the trellis too fast. Dormant prune to a weaker leader to delay extension. The apical bud pinching technique (described under the VA system) should work well with this system.

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Establishing the High Density Supported Apple Orchard

Part 6: Tips for Successful Establishment

Revised: January 1998
Prepared by: The Apple Team, OMAFRA
Editor: Ken Wilson, OMAFRA, Clarksburg

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More Tips for Successful Establishment

M.9 and other dwarfing rootstocks can have the disappointing habit of not growing as vigorously as expected the first year in the orchard. To reduce the possibility of this problem every effort must be made to encourage tree performance.

The new trees should be irrigated as necessary to ensure that growth will not be reduced due to lack of adequate soil moisture. Until growers become familiar with dwarfing rootstock/cultivar combinations it is recommended that the new trees be defruited at bloom in the planting year.

Cultivating to loosen soil around the base of the trees will also promote growth. This cultivation should be at regular intervals before weed and grass competition gets well established. It should be shallow in depth so tree roots are not disturbed. It should be discontinued in July to avoid stimulating late tree growth that may be susceptible to winter injury. Weak weed growth under the trees by late summer can help trees harden off, and reduce soil erosion over winter.

Herbicides for first year plantings can be used as recommended in Publication 75, "Guide to Weed Control" or Publication 360, "Fruit Production Recommendations" to reduce early weed competition.

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Pest Control

Proper integrated pest management practices are encouraged in the new planting. Aphids, leafhoppers, caterpillars, apple scab, fireblight and powdery mildew are the most important pests of young apple trees. Regular monitoring and well-timed pesticide applications minimize stress to young trees and maintains sufficient leaf surface for photosynthesis, respiration, and growth.

High density supported plantings often require less pesticide for effective pest control. For details on how to make this determination, consult factsheet "Guide

For Spraying Fruit Trees", Agdex 210/606.

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Rodent Control

The issue of rodent guards for vole and rabbit protection will depend upon grower experience in the area. Major losses are possible if rodent populations get out of control. Emphasis should be placed on grass cutting, elimination of suitable hiding areas and the use of bait stations. For more details, consult factsheet "Rodent and Deer Control in Orchards", Agdex 210/681.

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Sod Covers

Many growers prefer to plant a sod cover in the late summer of the first year. This cover should be of a non-legume grass that is not overly vigorous, resists traffic damage, and will not host nematodes. Tall fescue or creeping red fescue make excellent sod covers. This grass strip should be precise so no competition is placed near the trees. A minimum of 1 m bare strip for the tree row is usually adequate to reduce grass competition and to discourage rodents.

If weed competition in the bare strip gets out of control, a herbicide recommended for first year plantings should be used as outlined in Publication 75, "Guide to Weed Control" or Publication 360, "Fruit Production Recommendations" .

Some growers have established their sod in the fall before planting and killed out the tree rows with systemic herbicides. For more details on Sod Cover and its management, consult factsheet, "Soil Management for Orchard and Vineyards", Agdex 206/510.

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